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INTRODUCTION

Winter wheat has been an important crop of the chinook zone of southern Alberta for many years. With the introduction of improved varieties and better production management techniques, winter wheat is now being grown in many other areas of western Canada. To identify the successful production practices being employed by our most experienced producers, a survey was conducted in the late fall and early winter of 1983-84. Twenty above-average producers were individually selected by their district agriculturist to answer 131 questions dealing with all aspects of their winter wheat production practices. Each farmer was asked to think of a "typical year" (if there is such a thing), and their preferred or best management practices that would maximize yields within economic realities for their farm.

The data were compiled and analyzed showing trends by percentage which indicated the most popular practices employed by the top producers of winter wheat.

The latest research results and recommended production practices from the professional community are also presented in the publication.

The average yield of the producers surveyed was 26 per cent higher (44 bu/ac) than the 1983 provincial average (35 bu/ac). No one production factor auto-matically resulted in this higher yield. It is a combination of many factors, each contributing in a small way to an overall large yield increase.

Information in this publication follows the flow of events through a production year. Readers are challenged to compare their production practices with those outlined in this publication. The survey information is mainly subjective; however, clear trends are indicated when large differences in percentage occur.

SURVEY RESULTS AND DISCUSSION

CHARACTERISTICS OF THE SURVEY SAMPLES

Number of producer-survey returns	20
Average years of experience growing winter wheat	17
Average number of cultivated acres per farm	1808
Average acreage sown to winter wheat per farm	353

Soil Type	**%**
Dark Brown	75
Brown	25

Soil Texture	**%**
Clay loam	85
Sandy loam	15

Districts covered by the survey are: Medicine Hat, Lethbridge, Warner, Pincher Creek, and Claresholm.

Observation and Discussion

These 20 hand-picked top producers of winter wheat have rather large farms, have many years of experience, and represent most of the traditional winter wheat growing area of southern Alberta. Differences in production methods will occur when such a large area is being represented. The largest percentage figure will indicate the most popular production procedure, the other percentage figures indicate alternative methods or procedures employed.

PRODUCTION PRACTICES

Rotation Used in Winter Wheat Production

% Producers	Crop to Fallow Ratio	Most Common Cropping Order
45	1:1	Winter Wheat Fallow Winter Wheat (Sometimes barley or spring wheat in place of winter wheat)
30	2:1	Fallow Winter Wheat Barley or spring wheat Fallow Winter wheat (canola) Barley or spring wheat
10	3:1	Spring wheat Barley Barley Fallow Winter wheat (canola)
5	4:1	Canola Winter wheat Spring wheat Spring wheat Fallow
10	Continuous	Spring wheat Winter wheat (oats) Canola (winter wheat) Winter wheat (spring wheat) Spring wheat (oats)

Observation and Discussion

This survey shows that winter wheat is generally being sown on fallow land or canola stubble in the traditional winter wheat area of southern Alberta. The milder winters of the Chinook Zone often allow fallow seeding of winter wheat to be successful. Fallow seeding has some obvious advantages including: a) not having to delay seeding while waiting for the spring sown crop to mature; b) normal seeding equipment will work properly with ease, compared

to seeding into the high trash and hard soil conditions typical of fall stubble seeding; c) adequate seedbed soil moisture near the surface is more assured, and d) greater weed and disease control has been facilitated. The major dis-advantage of fallow seeding is that you greatly increase the risk of winter kill caused by the lack of snow cover protection from the cold. In addition, the risk of soil erosion is greatly increased.

Outside the Chinook Zone seeding winter wheat on fallow is a definite "no-no". A snow cover needs to be maintained to insulate the winter wheat from the harsh winter weather. Standing stubble helps ensure this snow cover. Only three to four inches (8 to 10 cm) of snow is needed to ensure adequate insulation from the cold to overwinter the wheat in most areas of the province. Figure 1 shows the variation in minimum survival temperatures during the late fall, winter and early spring. Temperatures at crown level (about one inch below the soil surface) must be kept above these minimum temperatures, or plant death will result. In less severe situations, where the crown is not killed, but the fall-grown leaves and roots are, then regrowth in the spring is usually slower than normal, leaving the crop more susceptible to insect damage, seedling diseases and weed competition. A blanket of snow helps ensure these higher temperatures needed to prevent this type of damage. Even in the chinook zone of southern Alberta, a snow cover formed by seeding into standing stubble is recommended, as winter temperatures are quite capable of plunging below these critical minimums. A rapid spring snow melt is also desirable to minimize the risk of damage from snow molds and ice encasement (see disease section).

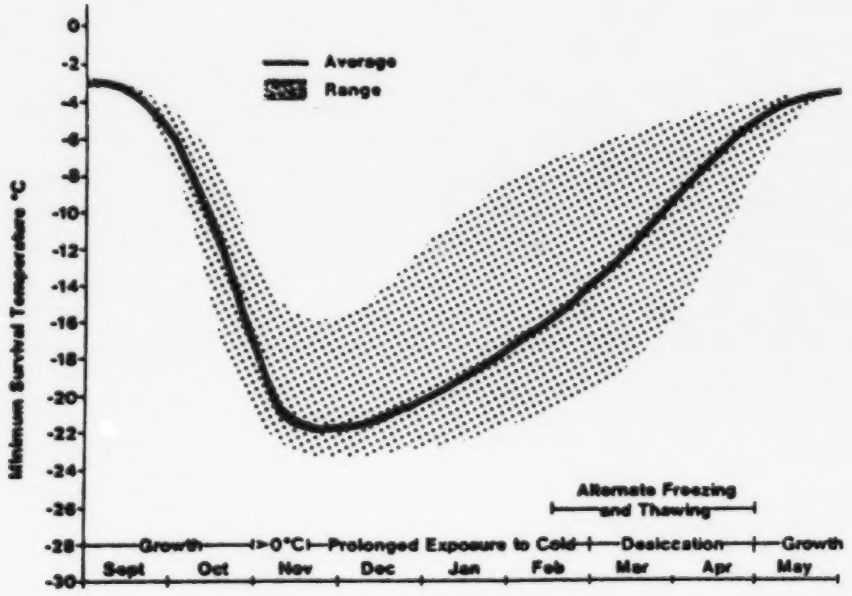

Figure 1. Minimal survival temperatures of Norstar winter wheat for the period September to May. Source - Crop Development Centre, University of Saskatchewan.

Handling of the Previous Crop Residue

	%
Not removed	95
Baled	5

Observation

Top producers return the crop residue to the soil. They realize its value in: lowering the soil erosion potential, improving the water holding capacity and infiltration rate, returning the many nutrients contained in the residue to the soil, improving the structure and texture of the soil, and increasing the nutrient exchange capacity. None of the top producers burned the crop residue.

Soil Tillage Practices

	%
Conventional till	80
Minimum till	15
Zero till	5

Soil Problems

The most frequently mentioned soil problems were:

	%
1: Wind erosion	70
2: Compaction	55
3: Salinity	50
4: Water erosion	50
5: Crusting	45

When asked if the crop to be planted and grown in this survey would be on summerfallow land, or if on stubble, what type, 80 per cent said it would be planted on summerfallow; 10 per cent on wheat stubble; 5 per cent on canola stubble; and 5 per cent on oat stubble. Therefore, most of the survey results contained in this manual on fertilizer application, tillage sequence, weed control procedures, etc., are applicable to winter wheat production on summerfallow land. The discussion material will contain information outlining differences in techniques to be used when growing winter wheat on stubble. Winter wheat must be grown in stubble for snow trapping outside the Chinook Zone of southern Alberta, and should be grown in stubble even in the Chinook Zone. (See discussion on "Rotations Used in Winter Wheat Production".)

Summerfallow Tillage Program Prior to Seeding Winter Wheat

As previously shown, 80 per cent of the producers surveyed were seeding their winter wheat on summerfallow land. Three quarters of the 80 per cent were working their soil four times.

a) The first tillage occurred in May, usually early May, to stimulate weed seed germination and kill winter annual weeds. Most were using a cultivator at a depth of about 4 inches.

b) The next two tillage operations were also performed with a cultivator, working about 3.5-4 inches deep, one in the month of June and one in July. The exact time was mainly influenced by when and how much moisture was received, and the resulting weed growth.

c) The last tillage operation generally occurred in August, using a cultivator, or cultivator and rod weeder, or cultivator and rod weeder and harrows, to help level and pack the land in seedbed preparation. Sixty-five per cent of the producers applied nitrogen and followed this with a cultivator-harrow-packer, or cultivator-rod weeder-harrow operation. The majority of the nitrogen applied was anhydrous nitrogen (see Fertility section).

Some producers used a blade in place of a cultivator in the first two operations. Seventy per cent did not work the land in the fall prior to the summerfallow year. This would leave the stubble standing to trap the maximum snow, increasing moisture reserves, and reducing the wind erosion potential.

Seedbed Firmness

Your shoe sole sinks		**%**	
⅛ to ¼ inch	Very firm	5	75
½ inch	Firm	15	
¾ inch	Slightly firm	55	
1 inch	Slightly loose	15	
2 inches	Loose	10	
3 inches or more	Very loose	0	

Observation

Most of the top producers obtained a fairly firm seedbed which is very important for winter wheat production.

Seedbed Moisture Just Before Seeding

	%	
Poor	5	
Fair	35	90
Good	55	
Very good	5	

Depth of Soil Moisture from Surface at Seeding

	%	
At surface	5	85
0.5 inch	10	
0.75 inch	0	
1 inch	15	
1.5 inch	35	
2 inches	20	
2.5 inches	5	
3 inches	10	

Observation

Seedbed soil moisture is maintained near the soil surface which is correlated with seedbed firmness and preseeding tillage observations. Maintaining seedbed soil moisture near the surface is also necessary to facilitate the shallow seeding depth requirement of winter wheat.

Rate The Final Seedbed You Obtained

	%
Poor	0
Fair	10
Good	75
Very good	15

Observation

Good yields start with a good seedbed.

Time of Seeding

	%	
3rd week of August	5	
4th week of August	5	
1st week of September	30	70
2nd week of September	40	
3rd week of September	15	
4th week of September	5	

Observation and Discussion

Most (70%) of winter wheat is seeded in the first two weeks of September, which agrees with research findings for southern Alberta. Seeding before September increases the liklihood of wheat streak mosaic, root rot, grasshopper damage, and decreases winter hardiness. In addition, seeding too early often results in a yield reduction and smaller seed size, even when good winter survival occurs. However, in the foothills or more northerly locations where early frost usually occurs, seeding time should be about one week earlier, to allow the crop adequate time to develop and harden before winter.

When seeding after September 15, soils are usually cool, resulting in slow germination, patchy emergence, decreased winter hardiness and insufficient top growth to prevent soil drifting. In addition, late seeding may result in delayed heading, later maturity, reduced hectolitre (bushel) weight, increased weed problems and reduced yields.

Seeding when the afternoon soil temperature is approximately 18°C usually allows sufficient remaining time in the season for proper growth and development (approximately to the 3rd leaf stage) to take place before freezeup (see Figures 2, 3, 4).

When fallow seeding in years of high cutworm risk, consideration should be given to delaying seeding until after mid-September. The main cutworm egg laying period is from about early August until mid-September. Maintaining a crust over the land during this period will greatly reduce egg laying. Delayed seeding may be advantageous in years of high grasshopper populations, as it reduces their feeding periods before a killing frost.

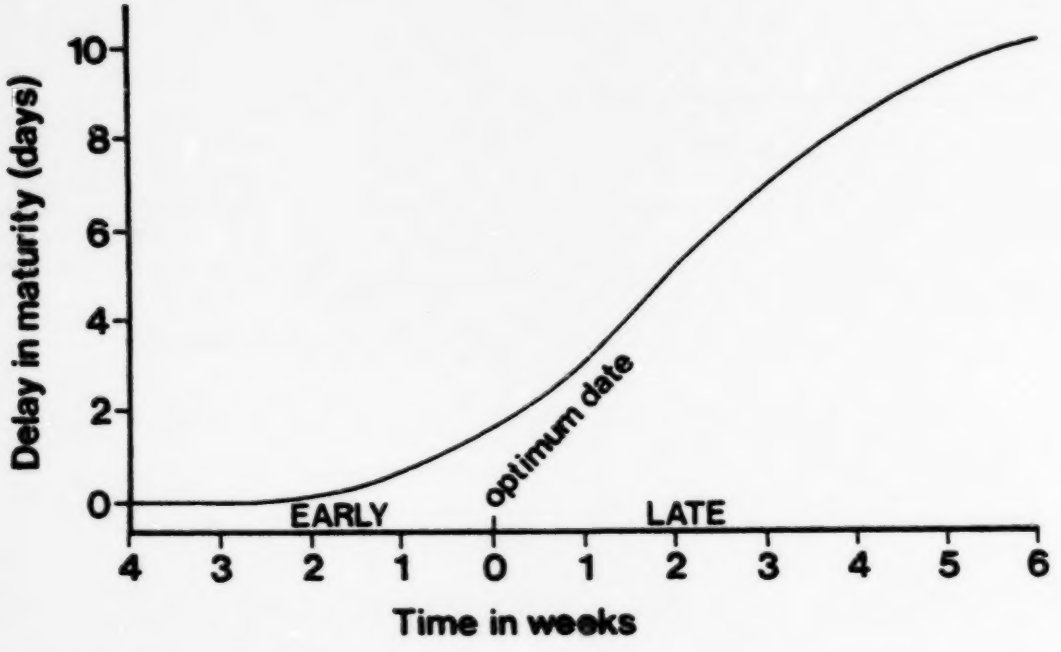

Figure 2. Influence of seeding date on maturity of winter wheat.
Source - Crop Development Centre, University of Saskatchewan.

Seeding Implement Used

	%	
Hoe press drill (no harrows)	85	95
Hoe drill	5	
Hoe drill & rod weeder & harrows	5	
One-way discer & packers	5	
Double disc press	0	
Air seeder	0	

Seeding Depth

	%	
0.5 - 0.75 inch	5	70
0.75 - 1.0 inch	20	
1 - 1.25 inch	15	
1.25 - 1.5 inches	5	
1.5 - 2 inches	25	
2 - 2.5 inches	25	
2.5 - 3 inches	5	

Observations
The hoe press drill is most popular. The reasons given for the hoe press drill preference were:

:- Good trash clearance
:- Good penetration
:- Accurate depth of seed placement
:- Ridges soil, allowing deeper seed placement to moisture while maintaining shallow emergence distance
:- Stubble remains standing

Discussion
Winter wheat should be seeded as shallow as possible down to adequate moisture for germination. Winter hardiness decreases as the depth of seeding increases beyond 1.5 inches (4 cm) of seed depth. The seeding depth is the amount of soil the young plant will have to grow through to reach sunlight. One advantage of the hoe press drill is that the furrows left by the packing wheels shorten the emergence distance to sunlight, allowing deeper seed placement to moisture. If, however, soil erosion occurs,

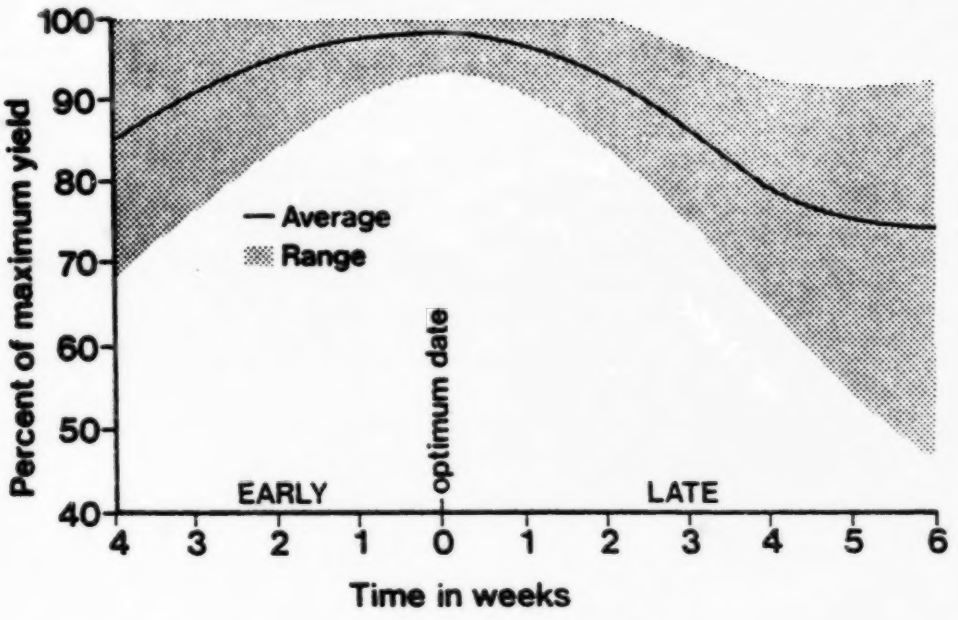

Figure 3. Influence of seeding date on yield of winter wheat.
Source - Crop Development Centre, University of Saskatchewan.

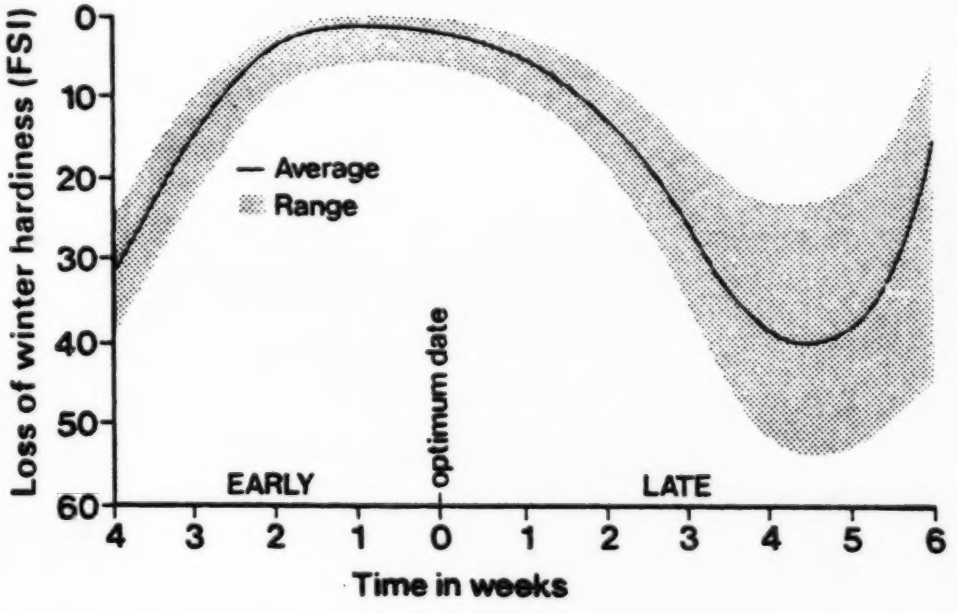

Figure 4. Influence of seeding date on winter hardiness of winter wheat.
Source - Crop Development Centre, University of Saskatchewan.

Note: It is not recommended to seed winter wheat 5 to 6 weeks later than the optimum date even though this graph shows an up-turn at that time.

These furrows can blow in, burying the young seedlings. This again underlines the importance of using soil erosion control methods, one of the best being stubble seeding.

When seeding into untilled stubble fields, obtaining adequate drill penetration and furrow fill is often a problem because of the dry packed fall soil condition. Hoe drills and minimum tillage drills provide the most positive penetration in this type of seedbed, and give the best assurance of good seed-soil contact through furrow closure with packed soil. It should be noted that soil moisture in stubble fields rarely improves with depth, so there is little to be gained by seeding deeper than the minimum required to give good coverage of the seed with packed soil.

When seeding on summerfallow, extra care should be taken to obtain a firm seedbed to facilitate shallow seed placement into moist soil (see Figure 5).

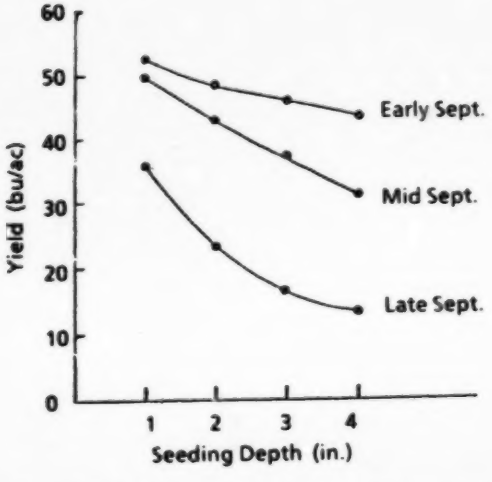

Figure 5. Effect of date and depth of seeding on grain yield of Norstar winter wheat. Average of 3 station years (Minto and Portage la Prairie).
Source - Crop Development Centre, University of Saskatchewan.

Field Operations After Seeding
None - 100%

Observation and Disucssion
The top producers using a hoe press drill did not harrow during or after the seeding operation. This maintains the furrow created by the packer wheel which:

a) helps prevent soil erosion
b) helps protect the young seedling
c) helps funnel even small amounts of precipitation to the seedling
d) minimizes emergence distance

In the case of stubble seeding, more stubble is left in an upright position for snow trapping when harrowing is avoided.

Class of Seed Used

	%
Pedigreed	32
Canada No. 1	20
Farmer's	48

Germination Testing
No test - 15%

Eighty-five per cent of the producers had their seed tested for germination which averaged between 80-100 per cent. Our current variety of winter wheat, Norstar, can be used for seed immediately after harvest, as a post harvest "curing" period for good germination is unnecessary.

How Often Do You Purchase Pedigreed Seed

	%	
Every year	10	75
Every 2nd year	10	
Every 3rd year	20	
Every 4th year	35	
When changing variety	15	
Other (5-8 years)	5	
Never	5	

Preference When Purchasing Seed

	%	
Foundation No.1	5	90
Registered No. 1	30	
Certified No. 1	50	
Certified No. 2	5	
Canada No. 1	10	

Observation and Discussion
Most of the top producers (75%) purchased pedigreed seed at least once every four years. Their preference when purchasing pedigreed seed is the Certified No. 1 level or higher. This gives them a guaranteed level of genetic purity, germination, freedom from disease and weed seeds. Good seed contributes to higher yields.

Seed Treatment

	%	
None	10	90
Dual	10	
Fungicide	80	
Insecticide	0	

How Often Do You Seed Treat

	%
Every year	90
Every 2nd year	5
Every 3rd year	5

Observation and Discussion
Top winter wheat producers seed treat every year with a systemic fungicide. This is strongly recommended to help ensure the establishment of a healthy stand and the control of smuts. Norstar, our current winter wheat variety, is very susceptible to smut.

Variety Sown

	%
Norstar	90
Sundance	10

Discussion
Norstar is our best current variety of winter wheat. It has the highest winter survival rating combined with the best milling quality, being equal to Winalta.

Introduction of a New Variety
When a new variety is first offered, with claimed advantages for their area, the top producers, on average, answered in the following way: "I wait -

Zero years	15	
One year	30	90
Two years	45	
Three years	10	

and then purchase pedigreed (90%) class of seed, enough to sow 10-20% of my winter wheat land (60%). I then try the new variety for two years (65%) before I reach a conclusion on its adaptability to my farm".

Observation
One year is not sufficient time to evaluate a new variety. Top producers try new varieties early after their introduction, on a small percentage of their land, using pedigreed seed.

Seeding Rate

	%	
0.5 - 1 bushel per acre	30	80
1.25 bushels per acre	50	
1.5 bushels per acre	15	
1.75 bushels per acre	5	

Observation and Discussion
Most of the top producers seed about one bushel per acre. The recommended seeding rate for winter wheat is the same as for hard red spring wheat.

How Often Do You Soil Test

	%		
Every year	15	60	80
Every 2nd year	45		
Every 3rd year	10		
Every 4th year	10		
Every 5th year	5		
Never	15		

Observation
At least once every four years 80 per cent of the producers soil test to aid in their fertility program decisions, with 60 per cent soil testing every other year.

Depth of Soil Sample Taken for Test

	%
0 - 6 inches	100
6 - 12 inches	77
12 - 24 inches	41

Do The Soil Test Results Show a Deficiency In:

		%
Potassium	No	95
	Yes	5
Sulphur	No	85
	Yes	15
Trace elements	No	90
	*Yes	10

* (Zinc, Boron and/or Copper)

Soil pH

	%	
6.1 to 6.5	5	
6.6 to 7.0	25	85
7.1 to 7.5	60	
7.6 to 8.0	10	

Organic Matter Content

	%
Low	40
Medium	60
High	0

Nitrogen Applied - (lb/acre)

	%	
None	5	
Under 10	5	
11 - 20	0	
21 - 30	15	
31 - 40	35	65
41 - 50	30	
51 - 60	5	
61 - 70	0	
71 - 80	5	

Observation
The majority of the top producers of winter wheat in southern Alberta applied 31 - 50 lb of actual nitrogen per acre.

Form of Nitrogen Applied

	%
Liquid	10
Anhydrous	45
Granular	45

When Was The Nitrogen Applied

	%	
Fall prior to seeding	65	70
Fall with seed	5	
Spring	25	
Not applicable	5	

Was The Nitrogen Deep Banded

	%
Yes	65
No	30
Not applicable	5

Observation and Discussion
1. Anhydrous application was considered deep band ing.

which accounts for 45 per cent out of the 65 per cent reported in the "Was The Nitrogen Deep Banded?" chart.

2. Winter wheat response to nitrogen is usually much greater than for spring wheat when moisture is sufficient (see Figure 6).

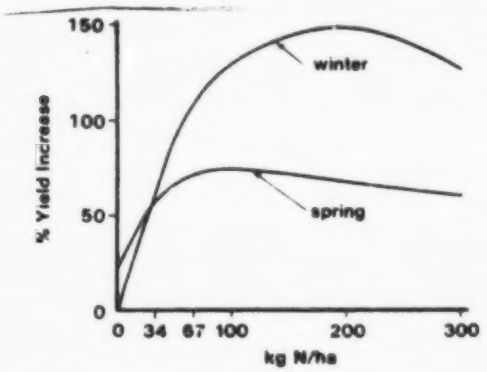

Figure 6: Effect of nitrogen fertilizer on yield of spring and winter wheat where moisture is sufficient.
Source - Crop Development Centre, University of Saskatchewan

Since most of the producers in this survey are seeding into fallow land, their soil nitrogen level will be higher than if they were seeding into stubble land. Therefore, less nitrogen was likely be applied.

Outside the Chinook Zone, where stubble seeding of winter wheat is necessary for winter survival, higher rates of nitrogen will be needed to:

a) Compensate for the decreased level of available soil nitrogen, particularly in the early spring when winter wheat has its highest demand for nitrogen. Most of the demand for nitrogen occurs prior to the end of June. Therefore, spring application of nitrogen should occur as soon as possible after the spring snow melt (see Figure 7).

b) Moisture is usually less limiting in central and northern Alberta, which allows for profitable usage of higher nitrogen rates.

3. Rates of fertilizer application should be based on soil test results. Present fertilizer recommendations suggest that, when soil moisture conditions are good, up to 45 kg N/ha (41 lb/acre) of ammonium nitrate, or 30 kg N/ha (27 lb/acre) for urea, may be applied with the seed. If additional nitrogen is required, it can be broadcast in the spring, using ammonium nitrate (34-0-0). Be careful not to apply excessive amounts of total fertilizer with the seed. Do not spring surface apply urea fertilizer (46-0-0), as volatilization losses in winter wheat will likely be very high.

When fall soil moisture is poor, the amount of nitrogen applied with the seed must be reduced or eliminated to avoid emergence problems. The nitrogen should be deep banded, fall broadcast and incorporated or spring applied.

Originally it was shown in laboratory studies that nitrogen applied in the fall decreased winter hardiness. However, recent field work suggests that when fall applied nitrogen is balanced with adequate phosphorus, no decrease in winter survival occurs. More research is still needed in this area.

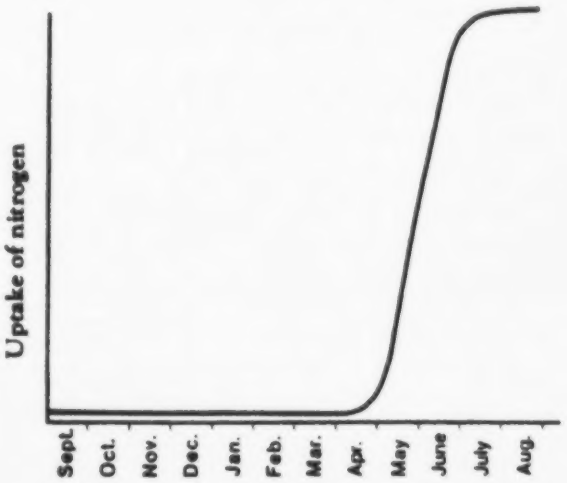

Figure 7: Nitrogen uptake by winter wheat
Source - Crop Development Centre, University of Saskatchewan

Phosphorus Applied (P_2O_5 lb/acre)

	%
None	5
Under 10	5
11 - 20	10
21 - 30	65
31 - 40	0
41 - 50	10
51 - 60	0
61 - 70	5

Observation and Discussion

1. The majority of the top producers applied 21-30 lb per acre of P_2O_5.
2. To get the maximum efficiency from either nitrogen or phosphorus, a proper ratio must be obtained. Soil test recommendations are the best source of this information. As a general guide - a 2:1 nitrogen:phosphorus ratio is recommended.
3. Since most Alberta soils are deficient in phosphorus, its application will improve winter wheat's early growth, help recovery from winter damage, advance maturity, help the plant resist disease, and increase yield.
4. The current variety of winter wheat (Norstar) is subject to lodging when grown in central and northern Alberta, where moisture is generally not limiting. Adequate phosphorus will help minimize this problem.

When Was The Phosphorus Applied

	%
Fall, prior to seeding	30
Fall, with the seed	65
Not applicable	5

Form of Phosphorus Used

	%
Liquid	15
Granular	80
Not applicable	5

Was The Phosphorus Deep Banded

	%
Yes	25
No	70
Not applicable	5

Observation and Discussion

1 The majority of the top producers (65%) applied phosphorus with the seed in the granular form (80%).
2 Deep banding of phosphorus has achieved some acceptance with 25 per cent of the top producers applying their P_2O_5 fertilizer this way. Since soils are usually cool and growth is slow in the fall, a small amount of phosphorus, approximately 15 lb/acre, should be subtracted from the total amount of phosphorus to be applied when banding. This 15 lb is placed with the seed during the seeding operation to provide a "starter effect". The 15 lb will ensure that sufficient phosphorus is readily available in the initial growth stages. Further research is needed in this area.

Potassium and Sulphur Applied

These nutrients were not generally applied, with only one producer applying about 15 lb/acre of potassium, and only two producers applying sulphur at about 13 lb/acre.

Research conducted over the past three years on many sites in southern Alberta has not generally indicated a need for potassium. Only isolated pockets of potassium deficient soils exist. If soil test results for potassium (0-6 inch level) show:

a) over 300 lb/acre - potassium should not normally be required.
b) between 250-300 lb/acre - a test strip could be tried.
c) under 250 lb/acre - a response may be observed from the addition of potassium.

Sulphur, like nitrogen, is mobile in the soil. To determine correctly the amount of available sulphur, a 6-12 and 12-24 inch sample should be taken in addition to the normal 0-6 inch soil sample. A deficiency of sulphur may exist in the 0-6 inch level because of leaching, yet an adequate supply of sulphur is available in the lower levels. Most of the farmland in Alberta contains sufficient sulphur for winter wheat production. Only about 13 lb/acre of sulphur is needed by winter wheat for a 50 bu/acre yield. Sulphur is a natural part of rain water, which supplies about 5-10 lb/acre per year in Alberta. If additional sulphur is needed, it is usually applied with sulphur-containing nitrogen fertilizer.

Micronutrients

None of the top producers applied micronutrients. Recent research has indicated, through tissue analysis, that micronutrients are rarely deficient in our soils. Norms, or values, for micronutrients, established mainly in the United States, are not applicable to Alberta soils and growing conditions. Leaf tissue analyses are the best indication of micronutrient deficiencies, rather than soil test results at present. Tissue analysis shows what the plant is actually receiving from the soil. Tests indicating Alberta soils to be low in micronutrients compared to established U.S. norms have produced plants that have not been low in micronutrients when tissue analyses were performed. More research is needed in this area. It should be noted that excessive micronutrient levels can result in extensive crop damage.

If an Uneven or Patchy Stand Occurs in the Fall, the Main Reason is:

	%
1) Deficient moisture	95
2) Depth of seeding	30

In The Spring

1) Lack of snow cover	25
2) Excess moisture	20
3) Deficient moisture	20

In the Spring, What Live Plant Population is Necessary Before You Will Leave the Crop to Grow to Maturity

	%
3 to 9 plants / ft^2	60
10 to 20 plant / ft^2	30
Don't know	10

Observation and Discussion

There is no one magical number of live plants that determines whether one should leave the stand or not. Many production factors determine this. For example, if the field is situated in a normally dry area of Alberta, one would tend to keep a stand with fewer live plants than if the field were in an area that traditionally has adequate spring moisture. In a dry area, by the time the field is cultivated once or twice to kill the winter wheat and prepare a new seedbed, and the land tilled again during the seeding operation, the seedbed will likely become so dry that very poor germination will result. Unless timely rains occur, the yield will be as poor or worse than if the light stand of winter wheat were left.

Winter wheat has a very good tillering ability which helps compensate for quite wide variations in plant population densities. As a rough rule of thumb, in southern Alberta 5-6 live plants per square foot, and 7-8 in central and northern Alberta, are adequate to justify leaving the stand. The ideal plant population for both north and south is 15 to 20 live plants per square foot.

Winter wheat almost always looks rough in the early spring, but can be quite good by harvest time.

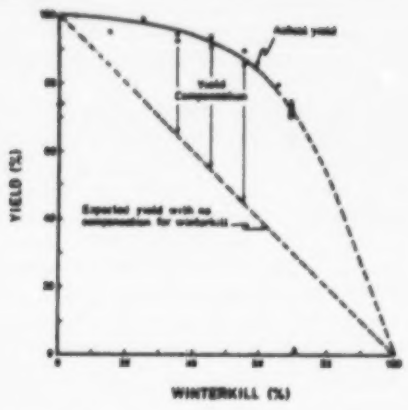

Figure 8. The effect of winterkill on yield of wheat.

From Figure 8 we can see that a 30 per cent survival will still yield 75 per cent of what the crop would have yielded with no winterkill.

To determine the number of live plants in the spring, wait one or two weeks after growth has begun and then dig up a few plants and examine them for **new root growth** from the crown. The new roots are pure white and thicker than the roots formed the previous fall. If new spring root growth is present, even though the leaves are dead, the plant will recover. In some cases, new leaf growth from the crown will be seen but no new root growth. A plant in this condition will likely die as soon as it uses up the food reserve stored in the crown.

If earlier spring determination of survival is desired, remove a few plants from the field on a warm day. Be careful to protect the removed plants when the air temperature is lower than the soil temperature at the time of removal. The air temperature may be below the plant's minimum survival temperature at that particular stage of winter hardiness, resulting in the plants' death. This would lead to a false conclusion of the extent of crop injury. Bring the excavated plants into a warm area of the house, place the crowns in a moist paper towel (or sand, soil, sawdust, etc.), cover, and allow to grow. Make sure the paper towel does not dry out at any time. Live plants can be identified by the presence of new white roots growing from the crown area.

If patchy winter survival occurs, the farmer must assess what amount of survival is acceptable, realizing that the areas winterkilled will likely become troublesome weed patches. Some farmers suggest that when only a few small scattered bare patches exist, one could sow winter wheat in these patches as a weed control measure. The winter wheat will stay in a low vegetative state allowing unhindered harvest operations. If many large patches occur, it may be more economical to seed these to spring wheat, recognizing the inconvenient harvest situation created by having two crop maturity dates.

If damage is extensive and a decision to reseed is made, the surviving winter wheat plants should be cultivated out as soon as possible to minimize loss of moisture, tie-up of soil nutrients, and to facilitate early seeding of the spring crop, as well as to minimize the chances of phytotoxic poisoning (plant to plant poisoning) of the new crop. Phytotoxic poisoning is also reduced by seeding immediately after destroying the winter crop and preparing the new seedbed.

It is highly unlikely that new varieties of winter wheat will be introduced in the near future with increased winter hardiness using current plant breeding methods. In 1902, Minhardi winter wheat had a field survival index (F.S.I.) of 492; in 1912 Kharkov 22MC had a F.S.I. of 499; and by 1977, our current best variety, Norstar, only has a F.S.I. of 514. The most hardy winter wheats from Russia, Alabaskaja and Ulianovka, have F.S.I.'s of 527 and 530 respectively, which gives plant breeders very little room to advance. Puma fall rye has a F.S.I. of 735. This helps explain the common saying that, "If you can't overwinter fall rye successfully, don't even try winter wheat".

WEED AND HERBICIDES

Most Common Weeds

	%
Stinkweed	95
Wild oats	60
Canada thistle	55
Buckwheat	45
Russian thistle	25
Cow cockle	25
Flixweed	25

What Herbicides Were Applied in the Fall

None 100%

Discussion

Winter wheat is a strong competitor against wild oats, and usually no herbicide control is needed. If, however, an exception does occur and wild oats appears in the crop, post emergent chemicals such as Hoegrass, Mataven, and Avenge are registered for use.

Broadleaved winter annual weeds such as stinkweed, shepherd's purse and flixweed, may be a problem. These weeds can be controlled by herbicides applied in the late fall or early spring. Originally, late fall application of a phenoxy type herbicide (2,4-D, MCPA, etc.) was considered to decrease winter hardiness. More recent research now suggests that fall weed control, on a field scale basis, does not adversely affect winter hardiness. Usually, this is the only weed spray operation needed in winter wheat production. Be careful not to introduce new weeds, such as downy brome, from other winter wheat production areas when purchasing seed. Ask to see the certificate of analysis for weed seed content. It is your legal right. Perennial weeds such as quackgrass, thistle, wild barley, etc., must be controlled prior to seeding winter wheat. Downy brome (cheat grass, *Bromus tectorum* L.) is a serious grassy weed for which there is no adequate registered chemical control. Control of downy brome is accomplished through rotation with spring seeded crops. Fall rye can be another bad grassy weed of winter wheat.

Herbicides Applied in the Spring

	%
Phenoxys	15
Phenoxy + Banvel	60
Tordon 202C	25

Observation
These top producers prefer the wider weed control spectrum of a phenoxy-banvel mix than is achieved by a phenoxy alone.

INSECTS

Insect Problems

	%
None	45
Grasshoppers	50
Cutworms	10
Sawfly	10
Wireworm	5

Insect Control Methods Used

	%
None	65
Seed treatment	20
Insecticide spray	30

Yield Loss From Insects

	%
None to light (5% or less)	100

Observation and Discussion
Most top producers experienced very few insect problems in winter wheat. They treated the seed with an insecticide when wireworms were a potential problem, such as when seeding into freshly broken land. (See "Freshly Broken Land versus Snowmolds"). Since wireworms move deep in the soil in late August, they do little damage to the emerging crop. In the spring, winter wheat growth is advanced enough by the time wireworms become active that the plants generally experience far less damage than that which can occur in later emerging spring wheat. Treating winter wheat seed with an insecticide is, therefore, of doubtful value. It is better to reduce the wireworm population by cropping an infested field with treated spring wheat.

It is evident that the top producers realize a threshold level of grasshopper infestation is needed before spraying is justified, in that 50 per cent reported they had grasshoppers, but only 30 per cent sprayed. The threshold level is 7 to 10 hoppers per square metre, depending on the crop value and the crop stress level from growing conditions. Insect problems are intensified when the crop is weak and thin which results in poor regrowth from the damage. (See "Time of Seeding", for cutworm, grasshopper implications.)

DISEASES

Diseases

	%
Piebald	60
Common root rot	30
Take-all root rot	20
Streak mosaic	15

Disease Control Methods

	%
Seed treatment	90
Delay seeding until surrounding crops are no longer green	40
Seed resistant varieties	30
Apply nitrogen to reduce piebald	5
Summerfallow	5

Yield Loss From Disease

	%
None to light (5% or less)	100

Observation and Discussion
Top producers have few problems with disease on winter wheat in southern Alberta. Since winter wheat is more susceptible to bunt and loose smut than spring wheat, producers are rightly treating their seed with a systemic fungicide.

Piebald (yellowberry or starchy kernel) is not really a disease. It is a result of low kernel protein (less than 12%) caused by a soil nitrogen deficiency. Soils low enough in nitrogen to cause piebald are also low enough in nitrogen to reduce yield. Therefore, by correcting the soil nitrogen level, the producer gains in both quality (grade) and quantity of the wheat produced.

Common root rot and take-all root rot affect winter wheat the same as spring wheat, with the main control being the use of nonsusceptible oilseed crops and oats in the rotation. The severity of these diseases can also be reduced by using high levels of phosphorus to promote a strong, vigorous root system, seeding at the proper time, and shallow seeding.

Wheat streak mosaic is a virus spread by the wheat curl mite. This mite is so small (1/100 inch long) that it is carried by the wind. Both mite and virus need a continuous supply of live plant material to survive. The control is therefore to have at least a week before seeding where all surrounding green material from spring grown crops or volunteer wheat and barley have matured and died. This practice should be routine for all winter wheat producers.

Snow mold is a term used to identify various low temperature fungi that attack winter wheat and fall rye. The damage from snow mold can be severe. These fungi operate when the temperature is at, or just below, the freezing point. An early and prolonged deep snow cover, which often occurs in the Parkland and Peace River area of Alberta, tends to favor snow mold. In addition, these fungi increase with

frequent winter cereal cropping or perennial forage cropping. Winter wheat should never be sown on a field that has just been taken out of a forage crop, because the risk of severe snow mold damage is great. Poor winter survival has often been blamed on the lack of cold temperature tolerance, when, in fact, the damage resulted from snow mold fungi. At present there is no recognized chemical control for snow mold in winter wheat.

Ice encasement and drowning are two other common causes of patchy stands, sometimes falsely blamed on the lack of cold temperature tolerance. Winter wheat should only be seeded on fields that are well drained and do not puddle or pond.

How Often Do You Inspect Your Crop for Possible Damage?

Average interval	10 days

With No Evidence of a Disease Problem, How Many Years Will You Sow Winter Wheat Back on Winter Wheat?

Years	%
Zero	45
One	0
Two	11
Three	17
Four	0
Five	5
Indefinitely	22

Discussion

Disease problems resulting from sowing winter wheat after winter wheat are a bit more serious than for spring wheat on spring wheat. Winter wheat is more susceptible to take-all root rot than spring wheat. Recropping also encourages the build up of snow molds. The more frequently the land is recropped to winter wheat the greater the likelihood for disease losses. However, suitable environmental factors must also be present for significant damage to occur.

Lodging

Lodging of Norstar was shown to be a minor problem in southern Alberta where moisture is usually limiting.

On the other hand, on irrigated land, or in the black and grey-wooded soil zones of Alberta, lodging is a severe problem with Norstar winter wheat. Fertility balance becomes very important.

HARVESTING AND YIELDS

Harvesting

	%
Swathed crop	65
Straight combined	25
Combination	10

The main reasons given for swathing were:

Uneven maturity
Reduce wind damage
Reduce sawfly damage

The main reasons given for straight combining were:

Faster
Saves money
Less straw to combine
Can leave higher stubble for snow trapping

Discussion

Winter wheat matures one to three weeks earlier than spring wheat, depending upon where it is grown. With earlier maturity winter wheat has a better chance of avoiding late, cool, wet weather and early fall frosts. Care must be taken once winter wheat has reached maturity, as the seed has essentially no dormancy. Warm wet weather, after it is swathed, can result in sprouting and rapid deterioration in quality. A number of producers have gone to straight combining to avoid this problem. A grain drier and aeration bins are helpful resources when straight combining.

One danger that comes with the earlier harvest of winter wheat is that the grain will be at higher temperatures when placed in storage. This favors moisture migration and spoilage as well as increasing the risk of insect infestation. Frequent inspections are necessary.

Do You Use Stubble Management to Improve Snow Trapping?

No	70%
Yes	30%*

* Method used was to leave the tallest standing stubble possible. Swather cutter bar deflectors were not mentioned, as they were not well known at the time of this survey. This device has merit and should be considered by farmers in the brown and dark brown soil zones.

Moisture of Seed at Swathing

	%
15 to 20 per cent	20
20 to 25 per cent	30
25 to 30 per cent	35
N/A	15

Observation and Discussion

Physiological maturity in wheat is reached when the moisture content of the grain is 35 per cent or lower. At this stage of crop development, it can be swathed safely without loss in grain yield or quality.

Yield

Yield achieved in 1983	—	44 bushels/acre
Average highest yields	—	63 bushels/acre
Five-year average yield	—	41 bushels/acre

For purposes of comparison in 1983 the provincial average yield was **35** bushels/acre. The long term provincial yield average is **36.1** bushels/acre.

How Much Does Winter Wheat Outyield Your Spring Wheat?

Average	—	10.8 bushels/acre
Range	—	5 - 22 bushels/acre

Dockage

	%
0 - 2 per cent	95
2 - 4 per cent	5

Bushel Weight

	%	
58 - 60	5	
60 - 62	50	70
62 - 64	20	
64 - 66	25	

Average Protein Content

	%
9 - 11 per cent	27
11 - 12 per cent	20
12 - 13 per cent	52

Usual Grade

Canada Western Red Winter No.1	75 per cent
Canada Western Red Winter No. 2	25 per cent

When Grades are Lower Than Expected, What Has Been the Usual Main Cause?

	%
Weathering	60
Piebald	40
Drought shrivelled	25
Cracked and peeled	5
Disease	5

Observation
Many producers identified more than one cause for grade lowering. Norstar winter wheat is subject to sprouting.

PASTURE & FORAGE

Fall or spring grazing of winter wheat (sown for grain production) should be looked on as a practice done only in emergency situations. In the fall, the amount of forage provided by the small prostrate seedlings is very little. Additionally, livestock tramping down standing stubble decreases its snow trapping ability, and increases its soil erosion potential. If the field is soft or wet, mechanical damage by tramping or the cattle pulling out whole plants when grazing increases. Heavy fall grazing may interfere with the plant's ability to build up the energy reserves required for winter survival and a quick start in the spring. Grazing decreases the amount of young plant material remaining to protect the soil surface from erosion.

In the spring, winter wheat starts rapid growth early, providing good early season forage. However, grazing or cutting will reduce the grain yield proportional to the intensity and duration of forage removal. Some delay in maturity can also be expected.

Fall rye produces more forage before winter and in early spring than winter wheat. It also withstands mechanical damage better from livestock grazing. For these reasons, fall rye is usually the preferred winter cereal for fall and early spring forage production.

CROP INSURANCE

All-risk hail and crop insurance is available for winter wheat in the traditional growing areas of southern Alberta (south of the Bow River). Application must be made in the summer prior to August 31 for all-risk insurance, including winter survival. In the area north of the Bow River no winter survival insurance is available. Regular spring/summer all-risk insurance may be purchased prior to the usual cut-off date of April 30. This winter wheat insurance is subject to a spring field inspection to verify acreage and freedom from winter kill.

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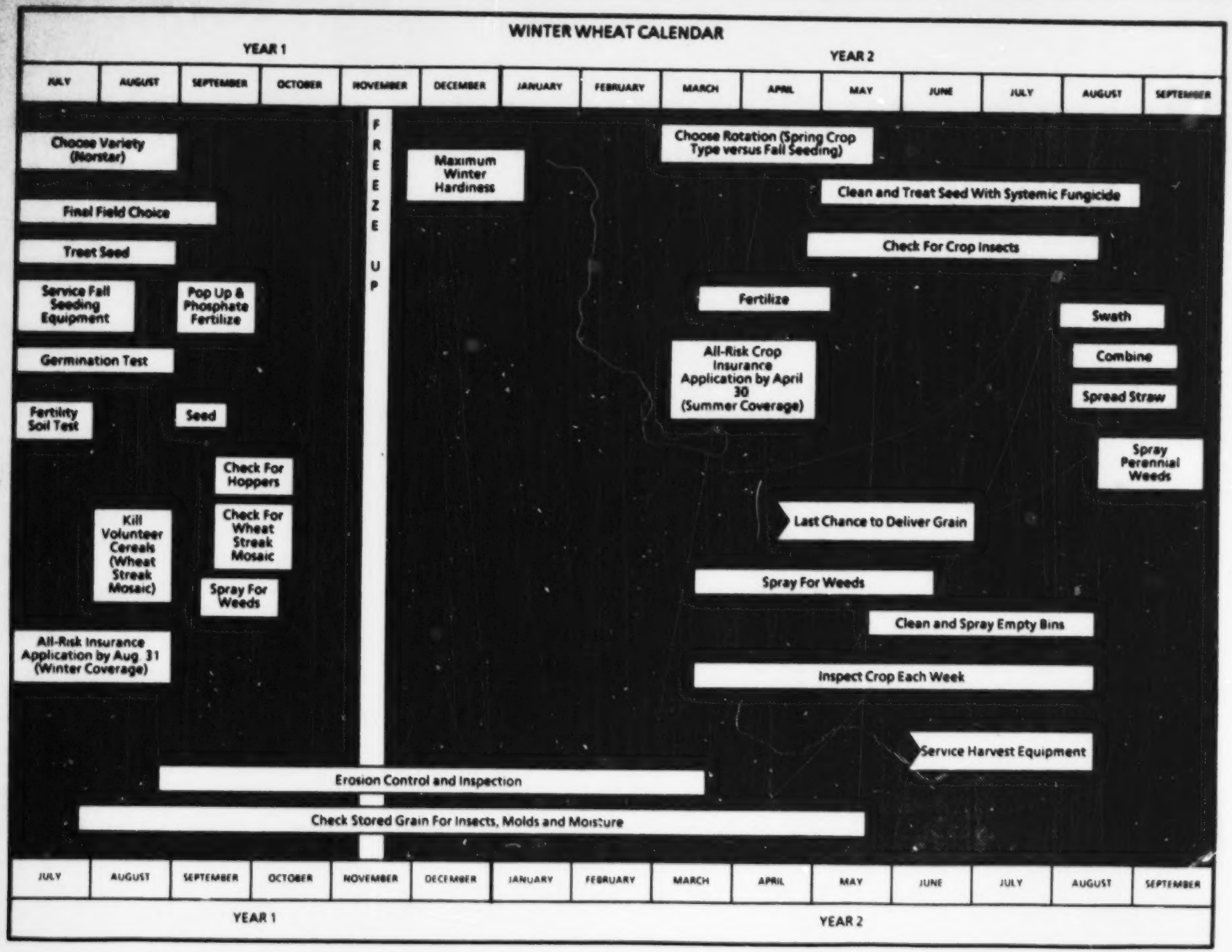
WINTER WHEAT CALENDAR
YEAR 1
YEAR 2
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
Choose Variety (Norstar)
Final Field Choice
Treat Seed
Service Fall Seeding Equipment
Pop Up & Phosphate Fertilize
Germination Test
Fertility Soil Test
Seed
Check For Hoppers
Kill Volunteer Cereals (Wheat Streak Mosaic)
Check For Wheat Streak Mosaic
Spray For Weeds
All-Risk Insurance Application by Aug 31 (Winter Coverage)
FREEZE UP
Maximum Winter Hardiness
Choose Rotation (Spring Crop Type versus Fall Seeding)
Clean and Treat Seed With Systemic Fungicide
Check For Crop Insects
Fertilize
All-Risk Crop Insurance Application by April 30 (Summer Coverage)
Swath
Combine
Spread Straw
Spray Perennial Weeds
Last Chance to Deliver Grain
Spray For Weeds
Clean and Spray Empty Bins
Inspect Crop Each Week
Service Harvest Equipment
Erosion Control and Inspection
Check Stored Grain For Insects, Molds and Moisture
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
YEAR 1
YEAR 2